ON CATARACT,

AND THE

OPERATION

FOR ITS

REMOVAL BY ABSORPTION,

WITH

THE FINE NEEDLE

THROUGH

THE CORNEA.

BY

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The following is a reprint of several articles lately published in the Dublin Medical Press. It is arranged to serve as an Introduction to an account of the "Operation for the Removal of Cataract with the Fine Needle through the Cornea," lately published, and to be bound up with it. I intend to add on a future occasion chapters on the other operations, so as to make the whole a complete treatise on the subject.

CATARACT.

STRUCTURE OF THE LENS

AND THE

NATURE OF ITS OPACITIES.

It is scarcely necessary to state that cataract is the name given to that disease of the eye in which blindness is caused by loss of transparency in the crystalline lens; and under that name, therefore, all opacities whatever of that part should be considered. Certain appearances, generally accompanied by defective vision, have been denominated glaucoma; but if it is meant to attribute these appearances and the defective vision which accompanies it to any loss of transparency in the crystalline lens, the term should not be used, the disease being in that case only a form of cataract. The application of two different names to the same disease is calculated to create confusion. I am not here, however, going to inquire what the disease called glaucoma is, I only want to have it settled that it is not cataract, or that if it is, it should be so called.

Notwithstanding all that has been already written on the subject, I think it is necessary to preface what I have to say respecting changes in structure of the crystalline lens by a description of that part in its natural and healthy state. It is, as every one knows, what is called a double-

convex lens, or rather like two plano-convex lenses united at their plane surfaces ; for its anterior surface is much less curved than its posterior : if not so, we should have it touching the iris, and perhaps interfering with the contractions of the pupil. Its minor axis measures about seven-fortieths of an inch ; or in other words, it is seven-fortieths of an inch thick; being about one half the length of its major axis or breadth. If we consider the surfaces of the lens to be spherical, we may say that the posterior is a segment of a smaller sphere than the anterior; or in other words, it is much more convex : the surfaces are not, however, strictly speaking, spherical, but perhaps spheroidical, or even elliptical or hyperbolical. These curvatures, it must also be recollected, are very different at different periods of life. In youth, perhaps we may say to the period of puberty, they are more curved, but from this period to forty-five or fifty, they remain stationary, when they become less so ; in fact, the lens in children is much thicker or more convex, while in old persons it becomes less convex, thinner, and flatter. The consideration of these changes are of great importance in a practical point of view, because although the greater convexity in early life does not seem to render the eye myopic, the flattening in advanced life causes it to become presbyopic. The greatest difference also often exists in different individuals in this respect, causing short or long sight throughout life, and even in the same individual the lenses appear to be frequently unequal, causing serious imperfection of vision. In incipient cataract, the curvatures of the lens often alter, sometimes causing persons to lay aside their spectacles, and sometimes to change them for others of a different focus. I am of course aware that the differences above alluded to may be attributed to other causes, but the undisputed fact that the lens becomes much flatter as we advance in life, and that at the same time the

eye becomes presbyopic, appears conclusive as to the cause and effect.

With a view to determine the causes of the changes which take place in vision from age or alteration in structure, it is necessary to consider the refractive power of the crystalline lens. The refractive power of the capsule has not been ascertained, but it is probably greater than any other of the transparent parts, although from its being so very thin it has little effect in altering the direction of the rays of light. The body of the lens is not of equal density throughout, being scarcely denser than water at the surface, but increases gradually in density to the centre, so that probably the rays do not pass through it in straight lines, but more or less curved. The mean refractive index is, however, held to be 1.384, and its principal focal length in air about one-third of an inch, perhaps its power may therefore be considered half way between water and glass. The density, and consequently the refractive power of the lens, becomes greater in advanced life, and for anything we know to the contrary, there may be some difference in this respect, as well as in the curvatures of the surface, in different individuals; so that, whether from this cause, or from some peculiarity in organization, or from defect of adjustment in the size or place of the pupil, very serious imperfections of vision frequently occur, and are often confounded with incipient cataract or impartial amaurosis. I every day meet with cases in which one eye is almost useless from some of these causes or a combination of them, and in which I know there is no loss of transparency of the lens or diminution in sensibility of the retina. In such cases relief may sometimes be afforded, especially in near-sighted persons, by the use of glasses calculated to compensate for or neutralise the defect; or perhaps we may effect some improvement by influencing the state of the

pupil by external applications. Imperfections of vision from the causes here noticed sometimes occur at the commencement of the period when the lens begins to flatten, and disappear in a year or two when the change in form arrives at its utmost extent.

Having premised so much with respect to the form and refractive power of the lens, it may not be superfluous to repeat what I have already stated respecting this part of the eye in the Cyclopædia of Anatomy ;* being convinced that a correct knowledge of the structure of any part is the first requisite towards a correct comprehension of the changes it undergoes from disease, and that no brief or meagre description is sufficient to convey that knowledge : it is as follows :—

"It has been already stated that there is a double convex lens within the sphere of the eye, at a short distance behind the external lens or cornea. This is the crystalline lens or crystalline humour, which gives additional convergence to the rays of light transmitted through the pupil. It is placed in a depression, formed for its reception on the anterior, compressed, or truncated portion of the vitreous humour, where that body approaches the back of the iris,

* For the article Eye in the Cyclopædia of Anatomy here alluded to, I venture to take this opportunity of claiming a fair consideration at the risk of being charged with undue partiality towards it, because it was prepared by myself. Articles in encyclopædias are frequently looked upon as mere compilations, and are therefore seldom referred to as depositories of original information, but many of those of the Cyclopædia of Anatomy were of the latter description. Upon the article on Anatomy of the Eye, no expense was spared by the then publishers, and I can safely say that no trouble was spared by me. I therefore can refer those who attach value to information derived from this source to it with confidence.

and constitutes part of the boundaries of the posterior chamber of the aqueous humour. In this depression it adheres firmly to the hyaloid membrane, and from the vessels of that structure derives its nutriment.

This double convex lens does not present the same curvature on both surfaces, the anterior being less curved than the posterior, in the ratio of about four to three. Attempts have been made to determine with accuracy the nature of these curvatures, first by Petit, and subsequently by Wintringham, Chossat, and others. The results of the numerous experiments of Petit lead to the conclusion, that the anterior curvature is that of a portion of a sphere from six to seven lines and a half in diameter, the posterior that of a sphere of from five to six lines and a quarter. From the same source it appears that the diameter is from four lines to four lines and a half, the axis or thickness about two lines, and the weight three or four grains. I am, however, inclined to agree with the observation of Porterfield, that, 'as it is scarce possible to measure the crystalline and the other parts of the eye with that exactness that may be depended on, all nice calculations founded on such measures must be fallacious and uncertain, and therefore should, for the most part, be looked on rather as illustrations than strict demonstrations of the points in question.' The method by which Petit arrived at these results must render them of doubtful value, the curvatures having been determined by the application of brass plates cut to the requisite form. The results of Chossat's experiments, conducted with great care, and with the assistance of the megascope, are thus stated by Mr. Lloyd in his treatise on Optics:—'This author has found that the cornea of the eye of the ox is an ellipsoid of revolution round the greater axis, this axis being inclined inwards about 10 deg. The ratio of the major axis to the distance between the foci in the generating ellipse he found to be 1.3; and this agreeing very nearly with 1.337, the index of refraction of the aqueous humour, it follows that parallel rays will be refracted to a focus, by the surface of this humour, with mathematical accuracy. The same author found likewise

that the two surfaces of the crystalline lens are *ellipsoids* of revolution round the *lesser* axis; and it is somewhat remarkable that the axes of these surfaces do not coincide in direction either with each other, or with the axis of the cornea, these axes being both inclined *outwards*, and containing with each other, in the horizontal section in which they lie, an angle of about 5 deg.' It must not be forgotten that these observations apply to the crystalline of the ox, not to that of man, and also that, as Chossat himself admits, the evaporation of the fluid part of the lens, or the absorption or imbibition of the water in which it is immersed, may materially alter the curvature. I cannot myself believe it possible to separate a fresh lens in its capsule perfectly from the hyaloid membrane without injuring its structure, and endangering an alteration in its form. Haller states that Kepler considered the anterior convexity to approach to a spheroid, and the posterior to a hyperbolic cone. Wintringham states the results of his inquiries as to this matter as follows:—'In order to take the dimensions of the eye of an ox, I placed it on a horizontal board and applied three moveable silks, which were kept extended by small plummets, so as to be exact tangents to the arc of the cornea, as well at each canthus, as at the vertex; then applying a very exactly divided scale, I found that the cord of the cornea was equal to 1.05 of an inch, the versed sine of this cord to be 0.29, and consequently the radius of the cornea was equal to 0.620215 of an inch. I then carefully took off the cornea, and replaced the eye as before, and found, by applying one of the threads as a tangent to the vertex of the crystalline, that the distance between this and the vertex of the cornea was 0.355 of an inch. Afterwards I took the crystalline out without injuring its figure, or displacing the capsula, and then applying the threads to each surface of this humour, as was done before to the arch of the cornea, I found that the cord of the crystalline was 0.74 of an inch, and its versed sine, with respect to the anterior surface, to be 0.189 of an inch, and consequently the radius of this surface was 0.45665 of the same. In like manner the versed sine to

the same cord, with respect to the posterior surface of the crystalline, I found to be equal to 0.38845 of an inch. Lastly, I found the axis of the crystalline and that of the whole eye from the cornea to the retina to be 0.574, 2.21 respectively. Whatever doubts may be entertained respecting the accuracy of the measurements of the lens, there can be none that the form is different at different periods of life, in the human subject. It also appears to differ in different individuals at the same period of life, and probably the curvature is not the same in both eyes. In other animals the difference in form is most remarkable. In the human fœtus, even up to the ninth month, it is almost spherical. Petit states that he found the anterior curvature in a fœtus of seven months, a portion of a sphere of three lines diameter, and the posterior of two and a half, and the same in a new-born infant. In an infant eight days old, the anterior convexity was a portion of a sphere of four lines, and the posterior of three. All anatomists concur in considering the lens to approach more to a sphere at this period. In childhood the curvatures still continue much greater than in advanced life; from ten to twenty probably decrease, and from that period to forty, forty-five, or fifty, remain stationary, when they become much less; being, according to the tables of Petit, portions of spheres from seven to even twelve lines in diameter, and on the posterior of six or eight. Every day's observation proves that the lens becomes flattened, and its curvatures diminished as persons advance in life. It is seen in dissection, when extracted by operation, and even during life; the distance between its anterior surface and the back of the iris being so great in some old persons, that the shadow of the pupil may be seen upon it, while at an earlier period it actually touches that part of the membrane. This diminution of the curvatures of the lens commences about the age of forty-five. Petit found the anterior convexity varying from a sphere of about seven to twelve lines diameter, and the posterior from five to eight in persons from fifty to sixty-five years of age. The alteration in power of adaptation, and the indistinctness of vision of near objects which

takes place at this period, is probably to be attributed to this cause, although a diminution of the muscular power of the iris, and consequent inactivity of the pupil, may contribute to the defect. It is also to be recollected that the density of the lens is much increased at this period, and that the young person whose lens presents greater curvatures does not require concave glasses, as the old person requires convex ones. The state of the eye, after the removal of the lens by operation for cataract, proves that it is a part of the organ essentially necessary for correct vision. When the eye is in other respects perfect, without any shred of opaque capsule, any irregularity or adhesion of the pupil, or any alteration in the curvature of the cornea, as in young persons who have had the lens properly broken up with a fine needle through the cornea, vision is so good for distant objects, that such persons are able to pursue their common occupations, and walk with safety through crowded streets, but they require the use of a convex lens, of from three and a half to five inches focus, for reading or vision of near; old persons, however, generally require convex glasses on all occasions after the removal of the lens. That the curvatures of the lens are frequently different in different individuals may be inferred from the frequency of short sight, or defective power of adaptation, not attributable to any peculiarity of the cornea. Petit states that he found lenses of which the two convexities were equal, and others of which the anterior was greater than the posterior, and more than once, one more convex on its anterior surface in one eye, while that in the other eye was in a natural state. He also occasionally found the lens as convex in the advanced period of life as in youth. I have repeatedly observed the perfection of vision and power of adaptation much greater in one eye than the other in the same individual, without any defect of the cornea, pupil, or retina; and occasionally have found young persons requiring the common convex glasses used by persons advanced in life, and old persons becoming near-sighted, and requiring concaves. The annexed letters show the difference of curvature at the dif-

ferent periods of life, as represented by Sömmerring. *C* is the lens of the fœtus; *B*, that of a child of six years of age; and *A*, that of an adult.

The colour of the lens is also different at different periods of life. In the fœtus it is often of a reddish colour; at birth and in infancy it appears slightly opaque or opaline; in youth it is perfectly transparent; and in the more advanced periods of life acquires a yellowish or amber tint. These varieties in colour are not visible, unless the lens be removed from the eye, until the colour becomes so deep in old age as to diminish the transparency, when it appears opaque or milky, or resembling the semitransparent horn used for lanterns. The hard lenticular cataract of advanced life appears to be nothing more than the extreme of this change of colour, at least when extracted and placed on white paper it presents no other disorganization; but the lens of old persons, when seen in a good light and with a dilated pupil, always appears more or less opaque, although vision remains perfect. The depth of colour is sometimes so great, without any milkiness or opacity, that the pupil appears quite transparent although vision is lost. This is perhaps the state of lens vaguely alluded to by authors under the name of black cataract.

The consistence of the lens varies as much as its colour. In infancy it is soft and pulpy, in youth firmer, but still so soft that it may be crushed between the finger and thumb, and in old age becomes tough and firm. Hence it is that in the earlier periods of life cataracts may be broken up completely into a pulp, and absorbed with certainty, while in old persons they adhere to the needle, unless very delicately touched, and are very liable to be detached from the capsule and thrown upon the iris, causing the destruction

of the organ. On this account, therefore, the operation of extraction must generally be resorted to in old persons labouring under this form of cataract, while the complete division of it with the needle and exposure of the fragments to the contact of the aqueous humour secures its removal by absorption in young persons. It must not, however, be forgotten that the softer lenticular cataract occasionally occurs in advanced life.

The crystalline lens is a little heavier than water. Porterfield, from the experiments of Bryan Robinson, infers that the specific gravity of the human lens is to that of the other humours as eleven to ten, the latter being nearly the same as water ; and Wintringham, from his experiments, concludes that the density of the crystalline is to that of the vitreous humour in the ratio of nine to ten ; the specific gravity of the latter being to water as 10024 to 10000. The density of the lens is not the same throughout, the surface being nearly fluid, while the centre scarcely yields to the pressure of the finger and thumb, especially in advanced life. Wintringham found the specific gravity of the centre of the lens of the ox to exceed that of the entire lens in the proportion of twenty-seven to twenty-six. The refractive power is consequently greater than that of the other humours. On this head, Mr. Lloyd, in his Optics, says—'In their refractive power, the aqueous and vitreous humours differ very little from that of water. The refractive index of the aqueous humour is 1.337, and that of the vitreous humour 1.339 ; that of water being 1.336. The refractive power of the crystalline is greater, its mean refracting index being 1.384. The density of the crystalline, however, is not uniform, but increases gradually from the outside to the centre. This increase of density serves to correct the aberration by increasing the convergence of the central rays more than that of the extreme parts of the pencil.' Dr. Brewster, in his treatise on Optics, says—'I have found the following to be the refractive powers of the different humours of the eye, the ray of light being incident upon them from the eye: aqueous humour 1.336; crystalline, surface 1.3767, centre 1.3990,

mean 1.3839; vitreous humour 1.3394. But as the rays refracted by the aqueous humour pass into the crystalline, and those from the crystalline into the vitreous humour, the indices of refraction of the separating surface of these humours will be, from the aqueous humour to the outer coat of the crystalline 1.0466, from the aqueous humour to the crystalline, using the mean index, 1.0353, from the vitreous to the outer coat of the crystalline 1.0445, from the vitreous to the crystalline, using the mean index, 1.0332.' Dr. Young says—'On the whole, it is probable that the refractive power of the centre of the human crystalline, in its living state, is to that of water nearly as 18 to 7; that the water imbibed after death reduces it to the ratio of 21 to 20; but that on account of the unequable density, its effect in the eye is equivalent to a refraction of 14 to 13 for its whole size.'

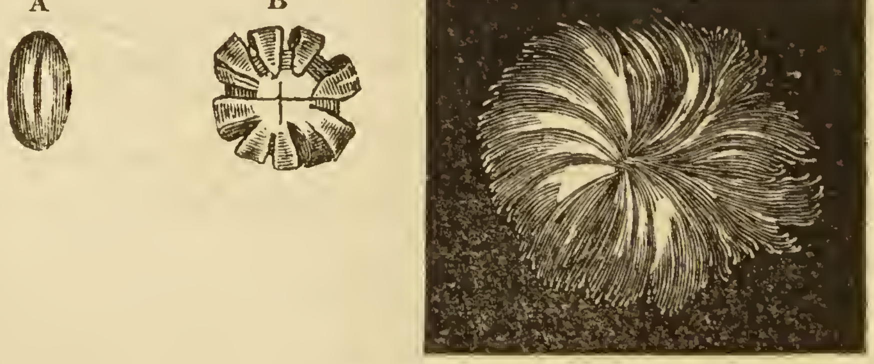
Respecting the chemical composition of the lens, Berzelius observes, that 'the liquid in its cells is more concentrated than any other in the body. It is completely diaphanous and colourless, holding in solution a particular animal matter belonging evidently to the class of albuminous substances, but differing from fibrine in not coagulating spontaneously, and from albumen, inasmuch as the concentrated solution, instead of becoming a coherent mass on the application of heat, becomes granulated exactly as the colouring matter of the blood when coagulated, from which it only differs in the absence of colour. All those chemical properties are the same as those of the colouring matter of the blood. The following are the principles of which the lens is composed; peculiar coaguable albuminous matter 35.9, alcoholic extract with salts, 2.4, watery extract with traces of salts 1.3, membrane, forming the cells 2.4, water 58.0.'

From the preceding observations it might reasonably be supposed that the lens is composed of a homogeneous material, such as albumen or gelatine, more consolidated in the centre than at the circumference; but this is not the case; on the contrary, it exhibits as much of elaborate organization as any other structure in the animal economy.

It consists of an outer case or capsule, so totally diffe from the solid body contained within it, that they must be separately investigated and described. The body of the lens, it has been already stated, consists of certain saline and animal ingredients combined with more than their weight of water, and when perfectly transparent presents the appearance of a tenacious unorganized mass ; but when rendered opaque by disease, loss of vitality, heat, or immersion in certain fluids, its intimate structure becomes visible. If the lens with the capsule attached to the hyaloid membrane be removed from the eye and placed in water, the following day it is found slightly opaque or opaline, and split into several portions by fissures extending from the centre to the circumference, as seen in fig. 2. This appearance is rendered still more obvious by immersion in spirit, or the addition of a few drops of acid to the water. If a lens thus circumstanced be allowed to remain some days in water, it continues to expand and unfold itself, and if delicately touched and opened by the point of a needle, and carefully transferred to spirit, and as it hardens is still more unravelled by dissection, it ultimately presents a remarkable fibrous or tufted appearance, as represented in the figure below, drawn by me some years ago from a preparation of the lens of a fish thus treated (the *Lophius piscatorius)*. The three annexed figures represent the structure of the lens above alluded to: *A* is the human crystalline in its natural state ; *B*, the same split up into its component plates ; and *C*, unravelled in the fish.

Fig. 2. C

A B



This very remarkable structure of the body of the lens

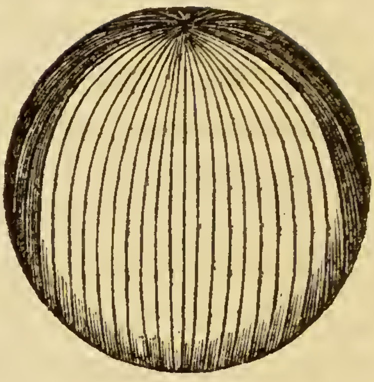
appears to have been first accurately described by Leeuwenhoek, subsequently by Dr. Young, and still more recently by Sir David Brewster. Leeuwenhoek says—'It may be compared to a small globe or sphere, made up of thin pieces of paper laid one on another, and supposing each paper to be composed of particles or lines placed somewhat in the position of the meridian lines on a globe, extending from one pole to the other.' Again, he says—'With regard to the before-mentioned scales or coats, I found them so exceedingly thin, that, measuring them by my eye, I must say that there were more than two thousand of them lying one upon another: and lastly, I saw that each of these coats or scales was formed of filaments or threads placed in regular order, side by side, each coat being the thickness of one such filament.' The peculiar arrangement of these fibres he describes as follows:—'Hence we may collect how excessively thin these filaments are; and we shall be struck with admiration in viewing the wonderful manner they take their course, not in a regular circle round the ball of the crystalline humour, as I first thought, but by three different circuits proceeding from a point, which point I will call their axis or centre. They do not on the other side of the sphere approach each other in a centre, but return in a short or sudden turn or bend, where they are the shortest; so that the filaments of which each coat is composed have not in reality any termination or end.'

Dr. Young differs from Leeuwenhoek as to the arrangement of the fibres and other particulars, and in his last paper corrects the description given by himself in a former one; he says—'The number of radiations (of the fibres) is of little consequence; but I find that in the human crystalline there are ten on each side, not three, as I once from a hasty observation concluded. In quadrupeds the fibres at their angular meeting are certainly not continued as Leeuwenhoek imagined.'

Sir David Brewster says that the direction of the fibres is different in different animals; the simplest arrangement being that of birds, and the cod, haddock, and several other

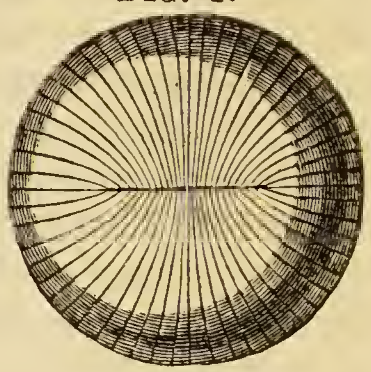
fishes. In it the fibres, like the meridians of a globe, converge to two opposite points of a spheroidal or lenticular solid, as in the annexed figure.

Fig. 3.



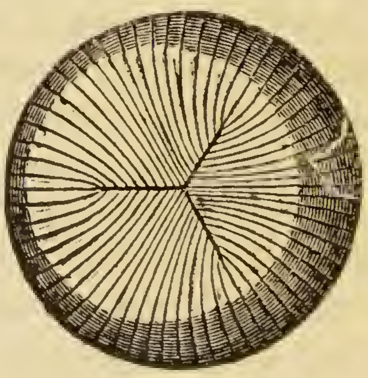
The second or next simplest structure he detected in the salmon, shark, trout, and other fishes; as well as in the hare, rabbit, and porpoise among the mammalia; and in the alligator, gecko, and others among reptiles. Such lenses have *two septa* at each pole, as in the annexed figure.

Fig. 4.



The third or more complex structure exists in mammalia in general, 'in which *three septa* diverge from each pole of the lens, at angles of 120 deg., the septa of the posterior surface bisecting the angles formed by the septa of the anterior surface,' as in the annexed figure.

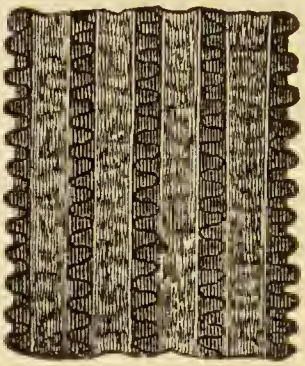
Fig. 5.



The mode in which these fibres are laterally united to each other is equally curious. Sir David Brewster says that he ascertained this in looking at a bright light through a thin lamina of the lens of a cod, when he observed two faint and broad prismatic images, situated in a line exactly perpendicular to that which joined the common coloured images. Their angular distance from the central image was nearly five times greater than that of the first

ordinary prismatic images, and no doubt whatsoever could be entertained that they were owing to a number of minute lines perpendicular to the direction of the fibres, and whose distance did not exceed the 12-500dth of an inch.

Fig. 6.



Upon applying a good microscope to a well-prepared lamina, the two fibres were found united by a series of teeth exactly like those of rack-work, the projecting teeth of one fibre entering into the hollows between the teeth of the adjacent one, as in fig. 6.

I have said that the lens consists of an outer case or capsule totally different from the solid body contained within it. This capsule is strong, elastic, and perfectly transparent. In the paper to which I have alluded in the Medico-Chirurgical Transactions, I gave the following detailed description of its nature and properties:—' The real nature of the capsule of the lens has not, I think, been sufficiently attended to; its thickness, strength, and elasticity have certainly been noticed, but have not attracted that attention which a fact so interesting, both in a physiological and pathological point of view, deserves. That its structure is cartilaginous, I should conclude—first, from its elasticity, which causes it to assume a peculiar appearance when the lens has been removed, not falling loose into folds as other membranes, but coiled in different directions: or if the lens be removed by opening the capsule behind, and withdrawing it through the vitreous humour, allowing the water in which the part is immersed to replace the lens, the capsule preserves in a great degree its original form, especially in the eye of the fish; secondly, from the density and firmness of its texture, which may be ascertained by attempting to wound it by a cataract needle, by cutting it upon a solid body, or compressing it between the teeth; thirdly, from its permanent transparency, which it does

not lose except on the application of very strong acid or boiling water, and then only in a slight degree; maceration in water for some months, or immersion in spirit of strength sufficient to preserve anatomical preparations, having little or no effect upon it. If the lens be removed from the eye of a fish dressed for the table, the capsule may be raised by the point of a pin, and be still found almost perfectly transparent. This combination of density and transparency gives the capsule a peculiar sparkling appearance in water, in consequence of the reflection of light from its surface, resembling a portion of thin glass which had assumed an irregular form while soft; this sparkling I consider very characteristic of this structure. The properties just enumerated appear to me to distinguish it from every other texture but cartilage; still, however, it may be said that cartilage is not transparent, but even the cartilage of the joints is semitransparent, and if divided into very thin portions, is sufficiently pellucid to permit the perception of dark objects placed behind it, and we obtain it almost perfectly transparent where it gives form to the globe of the eye, as in the sclerotic of birds and fishes. If the soft consistence, almost approaching to fluidity, of the external part of the lens, be considered, the necessity of a capsule capable itself of preserving a determinate form is obvious. If the lens were enclosed in a capsule such as that which envelopes the vitreous humour, its surface could not be expected to present the necessary regular and permanent curvature; nor could we expect that if the form of the lens were changed, it could be restored without this provision of an elastic capsule.'

The capsule is liable to become opaque and constitute cataract, as the body of the lens is. These capsular cataracts are easily distinguished from the lenticular. They never present the stellated appearance frequently observed when the texture of the opaque lens opens in the capsule, as it does when macerated in water, nor the uniform horny or the milky blue appearance of common lenticular cataract. The opacity in capsular cataract exists in the shape of irregular dots or patches, of an opaque paper-white ap-

pearance, and when touched with the needle are found hard and elastic, like indurated cartilage, the spaces between the specks of opacity frequently remaining perfectly transparent.

It appears to be generally assumed by writers on anatomy that a watery fluid is interposed between the body of the lens and its capsule, from an incidental observation of Morgagni when discussing the difference in density between the surface and centre of the lens ; hence it has been called the *aqua Morgagni.* The observation of this celebrated anatomist, in his Adversaria Anatomica, which has led to the universal adoption of this notion, is, however, merely that upon opening the capsule he had frequently found a fluid to escape. 'Deinde eâdem tunicâ in vitulis etiam, bobusque sive recens, sive non ita recens occisis perforata, pluries animadverti, illico humorem quendam aqueum prodire: quod et in homine observare visus sum, atque adeo credidi, hujus humoris secretione prohibitâ, crystallinum siccum, et opacum fieri ferè ut in extracto exsiccatoque crystallino contingit.' He does not, however, subsequently dwell upon or insist upon the point. I do not believe that any such fluid exists in a natural state, but that its accumulation is a consequence of loss of vitality ; the water combined with the solid parts of the lens escaping to the surface and being detained by the capsule, as occurs in the pericardium and other parts of the body. In the eyes of sheep and oxen, when examined a few hours after death, not a trace of any such fluid can be detected, but after about twenty-four hours it is found in considerable quantity. In the human eye a fluid sometimes accumulates in the capsule, constituting a particular form of cataract, which presses against the iris, and almost touches the cornea ; but such eyes are, I believe, always unsound. From this erroneous notion of an interposed fluid between the lens and its capsule has arisen the adoption of an unsustained and improbable conclusion, that the lens has no vital connexion with its capsule, and consequently must be produced and preserved by some process analogous to secretion. Respecting this matter I have observed, in the

paper above alluded to: 'The lens has been considered by some as having no connexion with its capsule, and consequently that its formation and growth is accomplished without the assistance of vessels; such a notion is so completely at variance with the known laws of the animal economy, that we are justified in rejecting it, unless supported by unquestionable proof. The only reasons which have been advanced in support of this conclusion are, the failure of attempts to inject its vessels, and the ease with which it may be separated from its capsule when that membrane is opened. These reasons are far from being satisfactory; it does not necessarily follow that parts do not contain vessels, because we cannot inject them; we frequently fail when there can be no doubt of their existence, especially where they do not carry red blood. I have not myself succeeded in injecting the vessels of the lens, but I have not repeated the trial so often as to make me despair of accomplishing it, more especially as Albinus, an anatomist whose accuracy is universally acknowledged, asserts, that after a successful injection of the capsule of the lens, he could see a vessel passing into the centre of the lens itself. Lobé, who was his pupil, bears testimony to this. The assertion that the lens is not connected with its capsule, I think I can show to be incorrect; it has been made from want of care in pursuing the investigation, and from a notion that a fluid exists throughout between the lens and its capsule. When the capsule is opened, its elasticity causes it to separate from the lens; especially if the eye be examined some days after death, or has been kept in water, as then the lens swells, and often even bursts the capsule and protrudes through the opening, by which the connexion is destroyed. I have, however, satisfied myself that the lens is connected with its capsule (and that connexion by no means slight) by the following method. I remove the cornea and iris from an eye, within a few hours after death, and place it in water, then with a pair of sharp-pointed scissors I divide the capsule all round at the circumference of the lens, taking care that the division is made behind the anterior convexity, so that the lens can-

not be retained by any portion of the capsule supporting it in front. I next invert the eye, holding it by the optic nerve, when I find that the lens cannot be displaced by agitation, if the eye be sufficiently fresh. In the eye of a young man about six hours dead, I found that, on pushing a cataract needle into the lens, after the anterior part of the capsule had been removed, I could raise the eye from the bottom of the vessel, and even half way out of the water, by the connexion between the lens and its capsule. It afterwards required considerable force to separate them, by passing the needle beneath the lens, and raising it from its situation. I believe those who have been in the habit of performing the operation of extraction, have occasionally encountered considerable difficulty in detaching the lens from its situation after the capsule had been freely opened, this difficulty I consider fairly referrible to the natural connexion just noticed.' When the lens enclosed in its capsule is detached from the hyaloid membrane, the connexion between it and the capsule is destroyed by the handling, and in consequence, it moves freely within that covering, affording to those who believe that there is no union between the two surfaces fallacious evidence in support of that opinion, which, if not sustained by better proof, should be abandoned. Dr. Young insists upon the existence of the natural connexion by vessels and even by nerves between the lens and its capsule: he says—'The capsule adheres to the ciliary substance, and the lens to the capsule, principally in two or three points; but I confess I have not been able to observe that these points are exactly opposite to the trunks of nerves; so that probably the adhesion is chiefly caused by those vessels which are sometimes seen passing to the capsule in injected eyes. We may, however, discover ramifications from some of these points upon and within the substance of the lens, generally following a direction near to that of the fibres, and sometimes proceeding from a point opposite to one of the radiating lines of the same surface. But the principal vessels of the lens appear to be derived from the central artery, by two or three branches at some little distance

from the posterior vortex, which I conceive to be the cause of the frequent adhesion of a portion of a cataract to the capsule about this point; they follow nearly the course of the radiations and then of the fibres; but there is often a superficial subdivision of one of the radii at the spot where one of them enters.' The great size of the vessels distributed on the back of the capsule in the fœtus strengthens the conclusion that the lens is furnished with vessels as the rest of the body. When the eye of a fœtus of seven or eight months is finely injected, a branch from the central artery of the retina is filled and may be traced through the centre of the vitreous humour to the back of the capsule, where it ramifies in a remarkably beautiful manner, assuming, according to Sömmerring, a stellated or radiating arrangement. Zinn declares that he found branches from this vessel penetrating the lens: 'Optime autem placet observatio arteriolæ lentis, in oculo infantis, cujus vasa cera optime erant repleta, summa voluptate mihi visæ, quam prope marginem ad convexitatem posteriorem dilatam, duobus ramulis perforata capsula in ipsam substantiam lentis profunde se immergentem cortissime conspexi.' He also quotes the authority of Ruysch, Moeller, Albinus, and Winslow, as favouring the same view. Against such authority I find that of the French systematic writer Bichat advanced; but on such a point his opinion is of little value."

With respect to the nutrition of the lens and the nature of its connexion with the capsule, it is necessary to state that observers entitled to confidence deny the existence of vessels in its structure, and consider that it grows by imbibing new matter from its capsule. Dr. Muller of Berlin says that the capsule of the lens is its matrix, which seems to secrete the layers of the lens from its inner surface, but that this has not been ascertained with certainty. Mr. Toynbee, in a valuable paper printed in the second part of the Philosophical Transactions for 1841, says that "the

mode of nutrition of the crystalline lens may be explained by supposing that the nutrient fluid is received by the cells and conducted to the lens, through which it is diffused ;" it being believed that cells are either interspersed, among the fibres, or that the fibres are composed of them. Notwithstanding this, I cannot admit that it is proved that the lens, or the cornea and vitreous humour, are destitute of vessels. I do not mean to deny that nutrition may be and is effected, as in the simpler forms of animal and vegetable life, without the aid of tubular vessels, and therefore cannot deny that the structures here alluded to may be so nourished ; but the question is not yet settled. Microscopic observations of fluids which are easily diffused, separated, and diluted, may be relied upon ; but those on organized solids not admitting of subdivision without destruction, cannot be received with so much confidence. Microscopic observers have, perhaps, been going a little too fast, and must allow us a little breathing time before we can accept all that is offered by them ; and the more especially because the instrument has been laid hold of, for the purpose of display, by ignorant persons totally unacquainted with its use, and incapable of making correct observations. The question, however, of the vascularity of these structures, is not perhaps of so much practical importance, seeing that, whether vascular or not, they undergo the same changes, both in health and disease, as vascular parts do. The cornea heals by first intention, ulcerates, granulates, and cicatrizes, and the lens becomes opaque, softens, hardens, and even is partially converted into a calcareous structure. These changes I shall have to notice presently, when I come to consider the great variety of forms of cataract, and the other alterations of the lens caused by age, inflammatory action, and injury.

ON CATARACT OR OPACITIES OF THE LENS.

Having endeavoured to explain the form, properties, organization, and vitality of the lens, I have now to consider the changes it undergoes from age, inflammation, imperfect or irregular nutrition, and injury. Writers on diseases of the eye enumerate a great variety of cataracts, applying different names to every different appearance which these opacities assume, as they have done with respect to opacities of the cornea. This, however, is of little use, causes unnecessary trouble and confusion, and diverts the mind from the investigation of the real cause of these appearances. It is much better to consider the real nature of these changes, and to explain the state of structure belonging to them. The crystalline lens does not become opaque from a great number of different diseases affecting it; it is only the forms of opacity which are so numerous. In the first place, it must be obvious that the lens being composed of two structures so different in every respect as the capsule and the body of it, and that both these being liable to become opaque, there must necessarily be at least two very different forms of opacity, and hence the division of cataracts into capsular and lenticular. The lenticular is to be first noticed. From what has already been said respecting the change which the lens undergoes in advanced life, it is clear that it is liable to become still more changed from the same cause, and experience has proved that such is the case. In the great majority, it not only becomes much more flat, and hence long sight requiring convex glasses, but also coloured; acquiring an amber tint, although previously clear as water. In still more advanced life it

also loses its perfect transparency, and becomes slightly opaque or milky, although not so much so as to impair vision materially. This I conclude from the appearance it presents on dissection, and when seen in the living subject by causing the light to be reflected from it, especially when the pupil is dilated with belladonna. When this colour and loss of transparency increases still more, vision becomes impaired and the opacity becomes visible in the pupil, constituting the lenticular cataract of advanced life; one of the most common forms of the disease met with. But the lens at this period becomes not only coloured and milky or opaline, but also much firmer in consistence, and hence the hardness of this species of cataract. The appearance, however, of the hard lenticular cataract of advanced life varies very much. It generally resembles a piece of muddy amber, or still more, common horn, such as is used for lanterns; but is sometimes so brown that it cannot be seen behind the pupil unless a strong light be thrown on it obliquely, and hence probably the origin of the notion that there is a black cataract. The hard lenticular cataract frequently also presents the appearance which has been denominated glaucoma, a greenish shining hue not easily described, and scarcely to be represented on paper. This semitransparent, amber, horny or opaline state of the lens is not, however, by any means the uniform appearance of the lenticular cataract of advanced life; on the contrary, the cataract of old persons is often of an opaque white, or even a bluish white, like the lenticular cataract of early life, or it may be irregularly clouded, stellated, or combined with capsular cataract.

The stellated opacity of the lens which sometimes occurs in the lenticular cataract of old age, but more frequently in that of earlier life, it is necessary to consider distinctly, because it is the result of additional disorganization, and

indicates a softer state of the lens, rendering it more easily broken up and more fit to be absorbed. I have already shown that from its fibrous structure, the lens splits up into segments when immersed in water or other fluid, and from whatever cause it may be, a similar change sometimes takes place during life, constituting this stellated opacity or cataract. There is no difficulty in recognizing this state, or of perceiving that it depends upon a yielding of the natural structure, and that it is accompanied by a corresponding softness and looseness of texture favourable to division with the needle. This splitting up of the lens into segments, from the centre to the circumference, may be produced by removing it from the eye of a sheep or other animal enclosed in its capsule, and leaving it in water for a day or two. Thus treated it becomes opaque, while the bars of the stellated breach on its anterior surface are transparent, being in fact filled with water. Now, if we are to give a name to these different states, we may call the uniform amber or horny opacity, the hard amber or horny cataract of advanced life; and if marked by bars radiating from the centre to the circumference, we may add that it is stellated.

There is, however, another kind of opacity which occurs at an advanced period of life which presents a more or less stellated arrangement. This is produced by delicate slender white streaks which run in the direction of the fibres, and therefore from centre to circumference, the rest of the lens retaining its transparency, or being only slightly opaque; so much so, that persons with this kind of cataract often enjoy useful vision. These white streaks or veins do not, however, always or even frequently assume the stellated arrangement, but run as single streaks across the whole face of the lens, with perhaps one or two other streaks diverging from it about the centre. It is a remarkable, distinct, and easily recognized opacity, although it

often escapes notice, especially where the pupil is small; and is obviously very different in its nature from the hard, amber, or horny cataract just described. It is also remarkable for the slowness of its progress to perfect opacity, often existing for many years before it causes blindness and requires operation. Such cataracts are not, perhaps, harder than a healthy lens at the same period of life, and the streaks of opacity are obviously not slits or spaces formed by the receding of the fibres from each other, but an induration and consequent opacity of a certain number of them, the rest remaining transparent. I am surprised that this form of cataract has not been more particularly described and distinguished from the common hard stellated cataract, especially considering the anxiety shown to multiply varieties and vary names, for there can be no doubt of its being of a peculiar nature. It is it Mr. Mackenzie alludes to when he says—"It is not an uncommon appearance to see opaque *striæ* stretching from the circumference of the lens a short way into its substance;" and Mr. Lawrence notices it as a radiated cataract having the rays commencing at the circumference instead of at the centre, as in the more common or softer stellate cataract. "Lenticular cataracts (he says) are sometimes *radiated*, the opacity appearing in streaks or *radii*, with the intervals comparatively transparent. Those radii generally begin in the circumference of the lens—a circumstance which forms a striking contrast to the former species, in which the opacity first appears in the centre. In the ordinary state of the pupil we can hardly see the radiated opacity, because the centre remains transparent; perhaps a *small white streak or two* may be distinguished: it is not, however, till we have dilated the pupil by belladonna that we detect the opaque streaks in the circumference of the lens." I sometimes, however, find these opaque striæ in the lens without the

marginal radii. It is probably to this form of cataract Mr. Bowman alludes in the following passages* :—

"In the commencing cataract of middle or declining age, we not uncommonly find the posterior surface of the lens first affected, so that we look through the transparent lens upon an obviously concave opacity. This opacity sometimes, and indeed generally, encroaches from the margin in distinct streaks of irregular thickness, length, number, and distance apart; and we usually find that, when the pupil is widely dilated by belladonna, some at least of these streaks are traceable round the margin for some way over the anterior surface. So long as small portions of the hinder surface of the lens remain clear, the body and front being also clear, it is surprising how much visual power may remain. At a subsequent period, the centre of the lens begins to be cloudy, and then the progress towards blindness is more rapid. Now I can entertain no doubt that the streaks in these cases are sets or bundles of the superficial layer of lenticular fibres, reduced to a state of opacity by some nutritional change. There seems to be a disposition in the fibres of the lens to become opaque in their entire length when once they are morbidly altered at a single point: and hence the linear figure of the opacity. The opacity probably commences in the middle part of the fibres near the margin of the lens; and the arrangement of the fibres would account for the different length of the streaks, some approaching nearer than others to the central point on the surface.

In another variety of opacity in adults, there are streaks visible, either on the anterior or posterior surface, before the nucleus manifests any tendency towards dulness, but instead of converging from the border of the lens, they rather diverge from the central point. These streaks are also irregular in number and direction; and it has never occurred to me to distinguish in them any exact representa-

* Lectures on the Parts concerned in the Operations of the Eye. By W. Bowman, F.R.S. London. 1849.

tion of the edges of the mesial planes as they are seen on the surface of the prepared lens ; never, certainly, any trilinear figure. But a glance at the representation above given of the complex arrangement of the mesial planes in the adult human lens, will suffice to explain why they are rarely seen in such opacities. In the healthy lens they are in reality too near together, and too irregular, to be detected without a glass. The triple divergence from the axis can, even then, only be recognized for a short distance, beyond which the planes seem to diverge and branch without any attempt at geometrical precision. We cannot, therefore, wonder that an opacity, spreading from the centre of the surface of the lens, and which consists of broad, ill-shapen streaks, should fail to disclose the radiation of the mesial planes: although it seems highly probable that its seat is, primarily and essentially, rather in the edges of those planes than in the fibres themselves.

In the lenticular cataract of adults, the glistening, silky, fibrillation of the lens may be often seen ; but you will fail, even in the best-marked of these cases, to discover, with the naked eye, anything like regularity in the mode in which the fibres pass off from the central region. Before becoming acquainted with the complex arrangement of the planes of the human lens, I could not satisfy myself why the triple line of the mammalian lens should be unseen ; but the actual complexity is a sufficient reason. It explains, too, the appearances of many cases of opacity of the body of the lens, where the fibrous texture is in general obvious enough, but where, towards the centre, an amorphous, indefinable obscurity exists."

Of the hard lenticular cataracts of advanced life, we have then the amber or horny, the stellate, and the striated, but these are not the only varieties. Cataracts in old persons are often white and very opaque without any *radii*, presenting a muddy cream-coloured or even a bluish milky uniform surface, behind the pupil, and such often have an opaline lustre from a hard amber cen-

tral nucleus reflecting the light through a semitransparent superficial stratum. These cataracts appear so soft and pulpy that they often tempt persons to operate on them with the needle to cause their solution and absorption, but they are almost always hard in the centre, leaving a small nucleus undissolved for a very long time in the posterior chamber after operation, moving up and down with the motions of the eye. Besides these four distinct forms of hard lenticular cataract of advanced life, the amber, stellated, striated, and white or opaline, there are many intermediate varieties which might be enumerated under different names, and also many rarer varieties of the same species presenting such peculiarities that they might be described very properly as peculiar products of disease ; but my object is to direct attention to the usual forms with a view to ascertain their consistence and solubility for the purpose of determining which operation should be chosen for their removal. It should, however, be observed that all these lenticular cataracts are more transparent and softer at the circumference, because the lens in health is there thinner and softer, and consequently, that when the pupil is dilated with belladonna, they admit more light and appear less opaque at the margin, except indeed it be the striated cataracts which are often more opaque at the circumference.

Lenticular cataracts are not found in persons advanced in life only, they occur at every period from infancy to old age, but in early life they are very different in form, consistence, and colour. As the hard amber cataract is that which occurs most frequently in aged people, the light-blue or milky one generally constitutes the disease in younger persons. It is also much softer, frequently indeed softer than the lens is in its natural or healthy state at the same period of life ; and instead of being shrunk or flat, it is generally enlarged or swelled. Therefore, as

has been said, the hard amber-coloured shrunk lens most commonly forms the cataract of advanced life, while the soft milky-blue prominent one is found most frequently in early life. There are, however, many varieties and modifications of the disease at this period, as there are at the other. Of these varieties, that which most frequently occurs is the starred or stellated one already noticed as a variety of the harder cataract of advanced life: the lens, in fact, being not only opaque, but so disorganized or changed in structure, that it has split up on its surface and exhibits deep fissures radiating from the centre to the circumference. The colour, however, instead of being a dirty-white, as in old age, is a milky-blue, and the fissures are of a lighter tint, as if filled by water, which they probably really are, the whole being so soft and pulpy that there is no difficulty in completely mashing it up with the needle in operation. A variety of the striated cataract described as occurring in advanced life, is also often found in early life, the striæ commencing at the circumference and converging to the centre, and not being open fissures but opaque veins with transparent intervals between them. Sometimes a defined circular white spot, very opaque, is found occupying the centre of a transparent lens, with one or more equally opaque thick bars or veins radiating from it toward the circumference. In using the term vein, I mean veins such as exist in minerals. This central opacity with dense radiating striæ, is generally, but not always, accompanied by an equally dense defined opacity of the capsule of smaller size, easily distinguished by its chalky whiteness and cartilaginous appearance, constituting a variety of capsulo-lenticular cataract. This dense opacity of the lens has not, however, always the bars or striæ radiating to the edge, but exists alone in a lens perfectly transparent to the circumference, admitting of

very useful vision when the pupil is dilated with belladonna. Such are very slow in progress, sometimes, in fact, being permanent, and undergoing little or no change for many years, if not indeed for life, and they are often congenital, but I think not always, for I have sometimes found them in persons somewhat advanced in life who insisted upon it that they had always had good sight until a comparatively recent period. The late Mr. Tyrrel, in his book on Diseases of the Eye, describes the striated cataract, but does not, I think, appear to have distinguished it from the stellated. He says, alluding to the distortion or multiplication of objects in incipient cataract, "when these modifications of symptoms have presented themselves, I have found that the opacity of the lens has not been confined merely to the centre, but that one or two, or several, opaque radii have existed, passing from the centre to the circumference of the body." (Vol. ii., p. 355.) And again (p. 363), "In rare instances, when cataract commences from the circumference, and proceeds by radii toward the centre, these radii are at first confined to the posterior hemisphere of the lens. This opinion, however, is equally erroneous with that before adverted to respecting the anterior portion of the lens, as I have had opportunity of ascertaining by watching the progress of such cases, and subsequently extracting the cataracts." Mr. Saunders in his treatise (p. 133., pl. iv., fig. 3,) says:—"There is a form of the congenital cataract in which the centre of the lens is opaque and its circumference perfectly transparent. In these cases the lens remains of its natural size as long as its circumference preserves its transparency, which, if undisturbed, it will do for many years." Fig. 3, referred to, shows, he says, "a lens of which the centre is opaque and the circumference is transparent, with the exception of *three opaque radiated lines;*" and it shows also a small

defined opacity of the capsule over that of the lens, but smaller than it. I have now in this paragraph shown, that of the lenticular cataract of earlier life there are four varieties: the uniform light-blue or milky; the stellated, or split from centre to circumference; the radiated, with veins from the edge toward the centre; and that with an opacity in the centre, with or without white bars or thick veins running to the edge. But these are not all, for sometimes the opacity is irregularly clouded, as if the original fibrous structure of the lens was destroyed, and the part converted into a grumous mass, as it appears some weeks after having been freely broken up by the needle. Mr. Wardrop, in his essays on the Morbid Anatomy of the Eye (vol. ii., p. 81), says, alluding to this variety:—"Sometimes they are clouded in different parts, having the appearance of a flake of snow;" and Mr. Tyrrel (vol. ii., p. 364) says:—"Sometimes the surface of the opaque body appears flocculent, like the surface of a recently broken piece of spermaceti." These cataracts are very soft, and are speedily absorbed after breaking up. If they are to have a name, they may be called flocculent. There is yet another variety which I have often seen and operated on. It is a very light-blue cataract, the colour of milk and water, which evidently contains a quantity of fluid between the lens and its capsule, for it is quite prominent, pressing upon the iris so as to cause dilatation of the pupil, and almost, if not all out, touching the back of the cornea. This can be distinctly seen by looking at the eye in profile, or sideways, the patient facing the light. Before I was aware of the existence of this form of cataract, I was much surprised to find that in operating on it I did not break it up and scatter the pulp into the anterior chamber, as I do in very soft cataracts, but that the more I worked at it the less it moved. In fact, I had been all the time

moving the needle about within the capsule, but when I saw how it was circumstanced I brought the instrument up to the back of the cornea and tore open the capsule, when it was immediately mixed up with the aqueous humour as usual. Whether or not it is this variety which authors allude to under the name of Morgagnian cataract I cannot tell, because they seem to differ in their descriptions of it. Mr. Mackenzie, in his work on Diseases of the Eye, appears to describe it under this title. He says:—"The effusion of an opaque fluid between the lens and its capsule forms one of the rarest kinds of cataract. It is generally followed by dissolution of the lens, and not unfrequently by capsular opacity. So long as the cataract consists in a mere effusion between the capsule and lens, it presents a cloudy appearance, as if formed of milk and water imperfectly mixed. It is stated that if the eyeball is repeatedly rubbed with the finger through the medium of the eyelid, the clouds of opacity change their outline and position; and sometimes they do so merely on quick motion of the eye from side to side. The capsule is distended in cases of Morgagnian cataract, and pressing against the iris obliterates the posterior chamber and impedes the motions of the pupil. When the disease is purely Morgagnian vision is sometimes but slightly impaired, small objects escaping the observation of the patient, especially after the eye has been rubbed or moved, but after the lens dissolves, the sight is limited to the perception of light and shade." Mr. Lawrence says:—"Opacity of the fluid situated between the lens and its capsule has been called *cataracta Morgagniana;* but I doubt its separate existence. How can we determine that the fluid is opaque and the lens transparent? Can we suppose that this fluid is opaque and the lens remains transparent? I think, therefore, that in a practical consider-

ation of the subject this kind of cataract might be safely omitted." Beer speaks of such a cataract occurring suddenly in consequence of exposure of the eye to acid vapours, and adds observations which render it doubtful whether he understood the nature of the disease at all. In the cataract to which I allude, I do not think that it is the fluid which is opaque, but the lens behind it, which is, I think, a common soft cataract. Mr. Mackenzie adds, that a "pure Morgagnian cataract is not to be touched in the way of operation." The cataract I have been alluding to I frequently operate on with success.

Notwithstanding the varieties of lenticular cataract, both of advanced and early life, above enumerated, many other forms of disorganization of this body might be described. I have seen the lens of a beautiful pale opaque green after general inflammation of the eye, and other curious appearances of it are occasionally met with; but the greatest amount of disorganization is found in congenital cataracts, and where the eye has been destroyed by the inflammation commonly called iritis, but which should be called ophthalmia. When this happens the pupil is generally adherent to a white, thickened, hard, opaque capsule, within which is a shrunk, friable, white fragment, bearing no resemblance in structure to the original lens, and in congenital cataract, as shall be noticed presently, similar or equally great disorganization is observed. These shreds of lens are, I believe, what are called siliquose cataracts. That the lens sometimes, but very rarely, has earthy matter deposited in its structure, most probably phosphate of lime, is an admitted fact, and one of interest in a physiological point of view, when it is recollected that the nutrition of this part has been attributed to a secreting process rather than to the usual growth by vascular ramification. Mr. Wardrop records an example of it, and I have myself seen

streaks of white earthy material among the fibres of the lens in horses' eyes destroyed by inflammation. Mr. Wardrop describes it as "ossification of the lens," and states that "on dividing the crystalline lens its central portion was found converted into hard bone. The external laminæ of the lens were soft, but those nearer the centre became more consolidated, the central portion itself being of a deep brown colour, perfectly osseous, and exhibiting a laminated structure." And again, in his description of a plate of it:—"The ossification is seen commencing in the centre of the lens, and extending towards its circumference in the form of concentric bony laminæ. The central portion was a dark brown coloured and hard bone; the exterior laminæ were of a paler colour, and more friable." This example, thus authenticated, is of great value, because although ossifications of the capsule of the lens have been met with occasionally, conversion of the body of the lens into bone, or an earthy solid resembling it, is of extreme rarity. The lens has been found sometimes, although rarely, in congenital cataract converted into a white milky fluid. Mr. Saunders records two, in which opaque capsules were found filled with such material. In fact, there seems to be no end to the variety in form, consistence, and colour, observed in cataracts of long standing, especially when congenital, or caused by inflammation or injury, but it would be tedious and superfluous to enumerate all these under different names. In alluding to the causes of cataract and the possibility of its spontaneous cure, it will be necessary to call attention to cataract from wounds or other injuries of the eye. Here it is only necessary to say, that such cataracts are of a bluish-white appearance, and irregular flocculent composition; sometimes, when the wound in the capsule is very small, presenting the stellate form; sometimes, when the rent is larger, projecting in

the shape of a white fleecy mass through the pupil into the anterior chamber ; and sometimes, when the whole face of the capsule is torn open, swelling out so as to fill up the whole anterior chamber up to the very back of the cornea.

OF CAPSULAR CATARACTS.

I HAVE said above that "the lens being composed of two structures so different in every respect as its capsule and body, and that both these being liable to become opaque, there must necessarily be at least two very different forms of opacity, and hence the division of cataracts into capsular and lenticular." I have now to treat of the capsular. After what has been stated respecting the nature and structure of the capsule of the lens, it becomes obvious that opacities of it must be very different from those of the lens itself. I have said the capsule is composed of a hard, elastic, solid material, and have expressed my belief that it is nothing else but transparent cartilage. Of this I entertain no doubt; and the examination of capsular cataracts has strengthened this conviction. When the capsule has become opaque, it seems in fact to have merely degenerated into cartilage of a coarser structure, and consequently to have lost its characteristic delicate and perfect transparency ; while it has at the same time become thickened and harder. Such cataracts necessarily present appearances totally different from those observed in the lenticular form. There being no fibrous structure arranged from centre to circumference, there is therefore no stellated or striated opacity, but either one patch, more or less uniform, or a number of small patches, streaks, or dots, sometimes presenting a veined or marble appearance, sometimes an arborescent or meandering outline. This remarkable irregularity in shape must at all

times serve to distinguish the capsular from the lenticular cataract.

The whiteness or complete opacity of capsular cataracts is as characteristic of the disease as the irregular mottled, dotted, or marbled appearance. Sometimes, it is true, the opacity is not so dense, but in general it is as white and compact as paper, resembling the membrane within the external shell of an egg, and being either a uniform patch or an irregular one, with intervals or small spaces less opaque pervading it. The surface sometimes, if not generally, loses that perfect smoothness and polish which distinguishes the capsule in its healthy state, and becomes rugged or undulating; while at the same time it is so hard and tough that great force is required to tear it. It is even sometimes converted into a calcareous layer, constituting what is called ossification of the capsule. All these qualities of capsular cataracts are worthy of attention, because upon a knowledge of them depends the diagnosis previous to operation and the steps to be taken during its performance. It is easy enough to determine beforehand the consistence of a lenticular cataract and afterward to extract or break it up according to its density, but it is often not so easy to predict the amount of resistance to be expected in capsular cataract, or during operation to overcome its toughness or tenacity of attachment.

The varieties of capsular cataract are not at all so numerous as those of the lens itself. No two of them, it is true, are exactly the same in appearance, but there are fewer species or varieties truly distinct in their nature. There are, however, some perfectly so. The ossified or calcareous degeneration must be held to be one, and that called central cataract is another. This latter is a small defined circumscribed dense, white, opacity, about the size of the head of a pin, occupying the centre of a capsule otherwise

perfectly transparent. It sometimes is prominent, projecting from the surface in the form of a cone, sometimes is flat or nearly so. In general, the body of the lens is perfectly transparent where these central opacities of the capsule exist, but sometimes there is also a dense central opacity in it somewhat larger than the other. This central capsular cataract is sometimes probably congenital, for we cannot ascertain from the patient that it was observed at any particular period, or that it could be traced to any particular cause; sometimes, however, it exists in eyes having dense and extensive opacities of the cornea from purulent ophthalmia in infancy or from small-pox. I have seen them very small in a lady of sixty, who said that she never considered that her sight was worse than that of other people, and it is probable that after having been once formed they never increase. I have seen them remain unchanged for many years, and when large with a small pupil, I have afforded sufferers from them very useful vision by the daily use of belladonna.

One of the most common forms of capsular cataract met with is that which follows operations for cataract or injuries of the eye in which the lens has been wounded. It appears in two very different shapes. In one, it is thick, white, and very opaque; in the other, a mere film, resembling a broken cobweb. The thick, white, opaque capsule, remaining after injury or operation followed by inflammation, either fills the whole pupil and adheres all round to its margin; or it hangs or projects from its edge in an irregular flap or a rounded prominence. In either case it is as hard and elastic as dry parchment, and if detached by the needle remains undissolved and unabsorbed for a great length of time, on which account I either work a hole in the centre of it with the point of the needle, or detach it from the margin of the pupil all round, except at one spot,

where I allow it to adhere, finding that in process of time it shrinks and curls up into a white nodule, which, although it projects a little into the pupil, does not obstruct vision. Such may of course be extracted with a pair of forceps, but if they adhere extensively, this is not so safe or so easy of accomplishment as some think. The film resembling a broken cobweb is very common, almost always remaining after injury or operation where the capsule has not been extensively torn, and where inflammation has followed. This often exists in the shape of a few white strings, as thin as fine threads, running from one side of the pupil to the other, and having the intervals between them open and transparent; sometimes, however, it is a complete continuous film like an irregular cobweb. Such are very tough and difficult to be detached with the needle, the iris not affording sufficient resistance when they are pulled or drawn from it by the instrument. I am often obliged to twist them away by turning the curved needle round and round upon them. In some cases they may be divided with a sharp iris knife or cutting needle. The back of the capsule sometimes, but not often, becomes opaque after operation, and remains so after the lens has been completely absorbed; such opacities are very delicate, and being far back, are not easily seen; but with a dilated pupil become visible, and may be torn asunder without much difficulty. What has been called posterior capsular cataract, and described as existing with a transparent lens is, I am convinced, a radiated lenticular cataract in which the opaque striæ are confined to the back and margin of the lens. Capsular cataract never assumes the radiated or striated arrangement.

It often happens that both the capsule and body of the lens are opaque at the same time, constituting what are called capsulo-lenticular cataracts. These are generally

either congenital, or the result of injury or severe inflammation, but I have often seen opaque patches in the capsule in common lenticular cataracts both of advanced and early life. Sometimes, as has been already observed, the central cataract of the capsule exists with a central opacity of the lens itself. Such a one has been described and delineated by Mr. Saunders, and Mr. Wardrop appears to have observed similar examples. In capsular cataracts, either congenital, or in consequence of injury or destructive inflammation, the lens is often found reduced to a white and friable shred or fragment. This has been called siliquose capsulo-lenticular cataract.

Congenital cataracts are so called because they exist at birth. They are generally capsular, with a thin remnant of white disorganized lens enclosed, but sometimes they are firm lenticular cataracts with or without opaque capsules; or the lens is opaque in the centre with transparent circumference and transparent capsule. Sometimes, but rarely, the opaque capsule contains a white fluid, and sometimes the margin of the pupil is adherent. In fact, some of these cataracts exhibit as great change of structure and disorganization as those caused by severe injury or destructive inflammation, while others are simple lenticular cataracts, like those which occur in early life generally. As cataracts are not always observed in infants until they are some months old, we cannot say with certainty that they existed previous to birth, as they may have formed subsequently, if merely lenticular and without opacity of the capsule or much other alteration in structure; but if the capsule or centre be very opaque, or the lens shrunk or otherwise disorganized, we may with safety pronounce them congenital. I am inclined to believe that certain striated or partial cataracts which are met with in growing children commence before birth, because the subjects of

them exhibit symptoms of defective vision from the earliest period, and the progress of the cataract is so gradual that vision is not entirely lost until puberty or even later. True congenital cataracts, however, rarely occur, at least I can say that I have found them uncommon. Mr. Saunders, it is true, met with sixty cases in three or four years, but that arose from the success of his new method of operating, attracting patients to him who might have been permitted to continue blind for many years according to the old practice, and many of his cases may not have been congenital at all. It is a remarkable fact that these congenital cataracts occasionally, if not frequently, occur in more than one individual of the same family, as does congenital deafness. Mr. Saunders met with them in two brothers in one family, and two others, twins, in another. In a third family, a brother and two sisters were affected; and in a fourth, three brothers and a sister. I have met with the disease in three children of the same parents, also in two sisters and a brother, and in brother and sister. Mr. Lawrence has observed similar examples. It should never be forgotten that eyes affected with congenital cataract are sometimes otherwise defective, rendering an operation of no avail. In fact, there is congenital amaurosis as well as congenital cataract, and when the retina is insensible with opaque lens it is impossible in young subjects to ascertain before an operation that it is so. The motions and gestures of the child in search of light will afford some guide to the state of the retina, but there may be perception of light without ability to distinguish objects. This has sometimes caused great disappointment to the friends of children operated on, and has brought discredit upon the operator and the operation, but very unjustly, for the operation when properly performed generally succeeds. I think I can say that I never had an eye destroyed by in-

flammation following operation in young subjects, and I have operated on many.

In order to avoid the danger of rendering the subject confused or complicated, I do not enumerate among cataracts those opacities of the capsule which accompany adhesions of the margin of the pupil to it; but it must not be forgotten that in inflammations of the membrane of the aqueous humour and of the iris, the surface of the capsule, and even the capsule itself, become opaque. Although the membrane of the aqueous humour cannot be demonstrated on the anterior half of the capsule of the lens in a state of health, its presence there may be inferred from analogy and the effects of inflammation. It is only reasonable to conclude that if there be a membrane of the aqueous humour at all, it must extend to all surfaces in contact with that fluid, and the fact that adhesion does take place rapidly and perfectly in iritis, seems conclusive as to the existence of such a serous covering. In inflammation of the membrane of the aqueous humour with or without iritis, there can be no doubt that vision becomes slightly cloudy or hazy from loss of transparency of that portion of it which covers the back of the cornea. The speckled opacity is distinctly visible in syphilitic iritis. Opacity of that portion which covers the front of the capsule of the lens is not, however, so unequivocal, although I believe it often occurs, but whether or not permanent is doubtful. Of the frequent occurrence of distinct and well-marked opacities of the capsule where the margin of the pupil adheres there can be no question, and when they are extensive they must be called capsular cataracts. In almost all cases of iritis which terminate in contraction of the pupil and adhesion of its entire margin to the capsule, that part becomes either entirely or partially opaque; often with opacity, disorganization, and shrinking of the lens itself.

In less destructive attacks the margin of the pupil adheres only at certain points, but at these points distinct, well-defined white spots are formed. Opacities from the above causes, and of the above character, have been called spurious cataracts, and the degrees and varieties of opacity have been denominated fibrinous, flocculent fibrinous, clotted fibrinous, and trabecular fibrinous cataract. The term fibrinous, however, ceases to be applicable after some time, as fibrine, if any exists, is either absorbed or converted into permanently organized material.

THE SO-CALLED SYNCHISIS ETINCELANT.

There is a very remarkable and peculiar alteration of the lens which, from its rarity, as well as from its value as an example of extreme degeneration of organized animal structure, is well worthy of consideration; and especially so, because its nature has been mistaken by persons on the continent who have undertaken to describe it in ignorance of the accounts published in this country respecting its true character. This peculiar alteration or degeneration I described at a meeting of the Surgical Society on the 14th of January, 1843, in the following terms:—

"Dr. Jacob called the attention of the society to an appearance which presented itself in the eye of a person upon whom he lately operated for cataract in the City of Dublin Hospital. The man, aged 33, was, he said, what is called amaurotic, or in other words, his vision was very defective even in the other eye which was free from cataract, and therefore he was unwilling to operate from a conviction that he had an unsound retina to deal with; but at the earnest solicitation of the patient, he consented to let him have the chance which the experiment afforded. The cataract was lenticular, and although more of an amber

tint than is usual at this time of life, was otherwise not uncommon. The lens was freely broken up with the needle through the cornea, and was easily separated into pulp and fragments, some of which fell into the anterior chamber, and no inflammation requiring attention followed. In a month the greater part was absorbed, and in six weeks the whole, leaving a shred of opaque capsule attached to the margin of the pupil, but not large enough to interrupt the passage of light. As the cataract, however, disappeared, the iris became studded with delicate brilliant scales of metallic lustre, so numerous and large as to be easily visible with the naked eye, and still more conspicuous with the assistance of a lens. They were irregular in form, but with surfaces so plane and polished that they reflected the light freely, resembling, in a remarkable manner, the particles of mica in granite. The appearance continued until the man was discharged, having been visible for about a month, and may probably continue so for some time. Sight, as had been predicted, was not restored, the retina being unsound. Dr. Jacob reminded the society that earthy, and perhaps crystalline deposits in the lens and its capsule were not very uncommon, and that they had been met of so dense a nature as to lead to the application of the term ossification to them, although not to be considered at all of the nature of real bone. They are probably phosphate of lime, or perhaps ammonio-phosphate of magnesia with phosphate of lime, but that he left to the chemists to determine. He said that on another occasion, in breaking up a cataract of somewhat the same appearance, he was surprised to see a quantity of what appeared to be delicate needle-shaped crystals diffused among the fragments, but these disappeared with the cataract as it was dissolved. He also exhibited a drawing of a capsular cataract, the consequence of injury, which he had removed successfully, and which had presented on the surface an appearance of such metallic lustre that he was obliged to make the artist represent it with silver leaf, and added that these brilliant cataracts, in a less marked form, were not very uncommon, but in all of them the disease was of long

standing. Earthy deposits, he observed, were frequently found in the body of the lens in horses blind from cataract consequent on inflammation. The shell of bone sometimes found within the choroid of disorganized eyes, and generally called ossified retina, he observed, was probably of the same nature as these lenticular deposits."

I again called the attention of the society to the same subject on the 23rd of November, 1844, as follows:—

"Dr. Jacob said he had some observations to make on a peculiar appearance occurring in a cataract under his care at the City of Dublin Hospital. It occurred in a boy on whom he had operated about five weeks since. He had received a blow on the eye some years before which had cut the cornea and injured the iris, the black membrane of the aqueous humour on the back of the iris being torn from it and dragged in front. This led to cataract, with irregular pupil; it was evidently an unsound eye, and was one of those cases to which he gave the chance of an operation without any sanguine hopes as to the result. He had broken up the lens, which was soft and pulpy, and thrown the fragments into the anterior chamber in the usual manner. In about a week a large portion of the pulpy matter had been dissolved, but mixed up with the remainder were a number of small brilliant scales, resembling particles of gold leaf, perhaps not of so metallic a lustre, but having more the appearance of mica. He called the attention of the students to them at the time, and though they had since then partially disappeared, they were now, in the fifth week since the operation, distinctly visible, moving about in the anterior chamber. They are now fast dissolving, and in a week or ten days will probably have altogether disappeared. He would not offer any conjecture as to the nature of these scales, if he had not recollected a case which had formerly come under his notice. It was an instance of cataract, produced, as well as he recollected, by injury also. On breaking up the lens, he was surprised to perceive it fall into a pulp in the

anterior chamber, having the appearance of oil altered by cold. Some days afterwards on examining it with a lens of $2\frac{1}{2}$ inch focus, a number of needle-shaped crystals or spiculæ appeared moving about in the anterior chamber, each about a line in length. Knowing that the crystalline lens was composed of delicate fibres, he at first imagined that these might be some fragments of it, but all doubts on that point were removed when he discovered that after some days they were not dissolved, but remained even more distinctly visible as needle-form crystals than before, and he was led to consider whether they might not have been crystals of some of the phosphates of lime of the same nature as the metallic scales he had been just describing. He thought it very probable that these were crystals of some phosphate of lime, as chemists, in speaking of that substance, described both crystalline needles and crystalline laminæ. Some persons might allege that these were merely fibres of the crystalline lens, but his objection to that was, that being so, they would have dissolved in a few days, while both the scales and needles to which he had alluded continued undissolved in the chamber for many weeks. It might also be objected, that in natural or healthy animal structure no crystalline deposits took place, unless the enamel of the teeth and porcelanous shells might be adduced as instances of such; but whatever objections might be urged against such an occurrence in health, he would say that they were applicable to diseased conditions of the body. [Dr. Jacob here exhibited a drawing of another cataract upon which he had operated in 1839, the surface of which presented a brilliant metallic lustre, and the texture of which, it being capsular and free from injury, was remarkably tough and firm.] This he considered somewhat of the same character, but not so crystalline or calcareous. He was not aware that these appearances had been described already, but he should not be surprised if it was so; for his engagements did not permit him to search for such a fact in the immense mass of medical matter delivered by the press to the profession in the last few years; it would be like seeking for a needle in a bundle of

straw. Other parts of the eye were subject to calcareous deposits, even the cornea had been found with gritty particles in it, and those osseous cups, generally described as ossifications of the retina, were not uncommon. Calcareous deposits in the body of the lens had been described by Mr. Wardrop and others, and such were frequently found in the eyes of horses blind from cataract for many years. Conversion of the capsule of the lens into a material resembling egg-shell was not very rare ; all showing that there was no difficulty in admitting that phosphate of lime, or some similar deposit, was often made in the structures of the eye."

Notwithstanding these circumstantial descriptions of this very curious form of disorganization, recorded in the 212th number of the Dublin Medical Press for January 25, 1843, and again in the 310th number for December 11, 1844, I find that it has been described and commented on in the continental journals without the slightest reference to my notices. In the *Annales d'Oculistique*, an ophthalmological journal, published in Brussels by Dr. Cunier of that city, a communication appeared in the number for November, 1845 (nearly two years after my first notice), from Dr. Desmarres of Paris, describing an example of the same disease. It occurred in a woman, aged 58, whose sight began to fail from cataracts about eighteen years before, and who had the operation of depression performed on her left eye seven years, and on the right three years, before Dr. Desmarres saw her ; she then (September 22, 1845,) had dense capsular cataracts, dilated pupils, and tremulous iris, with little sight. These capsular cataracts were removed with a pair of nippers through an opening made in the sclerotic, and good vision followed, but in about a fortnight or three weeks after the following appearances were observed in the left eye: "Looking through the pupil, which was widely dilated, to the bottom of the

eye, which was perfectly black, I saw (says Dr. Desmarres) scales attached, brilliant as diamonds, moveable, and of a size to be compared only to grains of sand. They occupied different planes in the posterior chamber, appearing generally twenty or thirty at a time; becoming displaced from below upward with the motions of the eye, and being replaced by others equally brilliant and numerous. All these little luminous moveable points reflecting the light with a vivid brilliancy, appeared to descend by degrees to the lower part of the eye, when it remained immoveable, and showing themselves in greater number as the motions of the eye were more extensive and sudden. There was no unusual appearance in the anterior chamber, and vision was as good as could be desired after an operation for cataract; the patient complaining of some *muscæ volitantes* only.

In the same *Annales d'Oculistique* for April, 1846, Dr. Sichel of Paris called attention to this subject, and relates a case of the same kind which had occurred to him in 1841. The patient, a boy, aged 13, suffered from hydrophthalmia of both eyes, the left being much larger than the right, but still so free from disease as to enable the boy to read. In the right, which was soft to the touch, and scarcely sensible to light, was a yellow capsular cataract adhering to the pupil. On tearing this capsule with the needle, a flow of turbid, yellowish liquid took place, mingled with a quantity of scales of a golden-yellow lustre, which fell into the anterior chamber and filled it up completely. When this subsided a second flow of semitransparent yellowish material followed, resembling boiling water in its motion. These appearances continued for several weeks, and some of the brilliant scales were visible even in 1844, three years after. Dr. Sichel adds significantly: "It is astonishing that Dr. Desmarres, who, in 1841 and 1842, being my clinical clerk,

had seen with me this patient, should have lost all recollection of a fact so difficult to forget, and which gave peculiar interest to that which he himself published." But it appears that neither I, Dr. Sichel, nor Dr. Desmarres first noticed this curious disease, for it appears that M. Parfait-Landrau, an oculist at Perigueux, described it in a communication published in the *Revue Médicale*, t. iv., p. 203, in 1828. The patient was a gentleman, aged 70, who, for several years, had defective vision with *muscæ volitantes*. He says: "On looking into the depth of the posterior chamber, I could perceive little bodies oscillating in the bottom, shining with phosphorescent brilliancy. Notwithstanding the attention I had paid in this examination, seeing the novelty of the phenomenon before me, which appeared of high interest to science, I distrusted my own judgment, and fearing that what I saw was the reflection of some external object, I dilated the pupil with belladonna, when M. Galy, of the hospital of Perigueux, also saw distinctly little bodies like fine powder of liquorice, and amongst the number, which was very considerable, were seen some having the brilliancy of filings of gold. These little bodies oscillated throughout the entire extent of the posterior chamber, and when the eye was at rest fell to the bottom, but on the slightest motion rose and again fell. All this took place at such a distance that no doubt exists that they moved about in the vitreous humour. They were so numerous that they were well seen with the naked eye, nevertheless we examined them with a lens. Four days after this, the eye was submitted to a second examination, in presence of Dr. Vidal, a member of the medical jury of the department, and first physician to the hospital, M. Galy, surgeon of the same institution, and M. Renaud, another surgeon: these gentlemen recognized the phenomena above described, and consider it a duty they owe to the interests

of science to testify as to the correctness of the statements." M. Parfait-Landrau goes on to argue that these appearances serve to account for the *muscæ volitantes* and luminous spectra which so often disturb vision, but on this it is not here necessary to dwell. After all this, it seems strange that Dr. Desmarres should, in a work of considerable size on Diseases of the Eye, published in 1847, say: "There is not in science, to my knowledge, any observation similar to this (made by him), not even that of M. Parfait-Landrau."*

The reader will perceive that while I described this curious form of disease as occurring in the lens, subsequent writers on the subject referred it to the vitreous humour, and have actually named it accordingly. When the vitreous humour is disorganized by inflammation, and the hyaloid membrane loses its cohesion, the eyeball becomes soft to the touch and the iris generally tremulous; this has been named *synchisis*, and this supposed variety of it has been dignified with the title of *synchisis étincelant*, or *synchisis scintillans*. That the lens is the seat of the disease I entertain no doubt whatever. In one case I saw the peculiar material burst out of the capsule as I opened it with the needle through the cornea, and in the others the scales and needle-

* Without wishing to detract from the merits of French surgeons, it is only justice to those of other countries to remind the reader that while an acquaintance with the French language is so general elsewhere, that of German and English is very limited in France. Hence the facility with which even trivial communications made by Frenchmen obtain currency in England and Ireland, while valuable information afforded by us remains inaccessible to them; or what is worse, the information is used without acknowledgment, so as to appear original. This, however, is not perhaps so great an evil as the wilful and obstinate ignorance, or something worse, ostentatiously displayed in other places, and from which some London writers are not entirely free.

shaped crystals were so thoroughly embedded in the substance of the broken up lens, and were so obviously let loose in the aqueous humour as these fragments dissolved, that I could not be deceived. The description of M. Parfait-Landrau, I admit, supports the other view, for he saw these oscillating bodies in an eye which, although defective, was not considered to suffer from cataract; but as there are forms of cataract in which the capsule of the lens is distended with fluid, this may have been one of them, and in that fluid it probably was that these bodies moved. In Dr. Desmarres' case, the particles appeared upon extracting opaque capsules, and had probably been discharged from the lens in the previous operation of depression. Moreover, it does not appear that Dr. Desmarres' patient had any *synchisis* at all, for he says, after describing the disorganized state of the iris and its adhesions to the capsule, "*toutes les autres membranes sont saines.*" And again, "*les yeux avaient leur consistance normale.*" In Dr. Sichel's case there was a capsular cataract, but there is no reason for assuming that there was not a disorganized lens within it when it was opened. In M. Parfait-Landrau's case there was no softening of the eye, and therefore no *synchisis:* in fact, there is no evidence that the disease was in the vitreous humour. As to the possibility of anything floating about in a sound vitreous humour, it cannot be admitted for a moment; this structure, although a soft and delicate one, is a solid, and in a solid such particles could not move. As to the complete fluidity of this humour, even in softened eyes, much remains to be ascertained by careful dissection. It is much more probable that decomposition of the crystalline lens would afford products such as these described, than that a structure of such tenuity as the vitreous humour could generate them. The lens of all the structures in the body contains the elements of animal

organization in a state of the highest concentration, and liable as it is to become detached from its capsule, although still retained within it, presents a condition of parts in no other place to be observed. It is, indeed, when so detached, a lifeless material enclosed within living structure, where, although it does not act as a foreign body, it undergoes changes as peculiar as the extraordinary state in which it exists.

Since this curious form of disease was noticed, much discussion respecting its nature has been carried on in the continental journals; in which Dr. Stout of New York, Dr. Blasius of Halle, Dr. Bouisson of Montpelier, M. Petrequin of Lyons, and MM. Tavignot and Robert in Paris, have taken part. I cannot, however, discover that any material addition has been made to the descriptions given of it by M. Parfait-Landrau in 1828, and by me in 1843 and 1844. It has been suggested that the crystalline scales and needles are of the nature of cholesterine, but no evidence of it has been afforded, and it seems improbable that delicate and minute particles of such a material could remain unchanged in the aqueous humour for months or perhaps years. I have devoted more space to this inquiry than perhaps it is worth, but the circumstances stated compelled me to do so.

OF THE CAUSES OF CATARACT.

Cataracts, in the majority of cases, are the consequence of the change which takes place in transparent parts from age, or of inflammation, or accidental injury. We every day, it is true, see cataracts which we cannot trace to any cause, but that many are owing to either of these three causes can scarcely be denied. It has already been shown that the lens undergoes three obvious changes as we

advance in life. It becomes harder, acquires an amber colour, and is flattened, or rendered less convex. In addition to this, it frequently, if not generally, loses its perfect transparency, and becomes slightly opaque, milky, or clouded; which, if increased, causes such obstruction to the transmission of light, that it constitutes cataract, and impairs or destroys vision. These changes, which the lens undergoes in common with other structures, in some cases proceed to still more remarkable alterations. *Striæ*, or veins of white opaque matter form, or the fibrous texture separates, and it splits into segments, as has already been stated. This being the case, it does not appear unreasonable to attribute the various forms of cataract which are seen in old persons to these organic changes where no evidence exists of the operation of other causes. That cataract, both capsular and lenticular, is often caused by inflammation cannot be denied. In general inflammation of the whole eye, commonly called iritis, terminating in contraction of the pupil, with close adhesion of its margin to the capsule of the lens, not only is the capsule rendered opaque, thick, and hard, but the lens itself is reduced to a white, shrunk, disorganized mass; and when the pupil is not contracted or adherent, but dilated, the body of the lens becomes opaque and of a greenish-amber tint, often called glaucomatous. These effects of inflammation are obvious, but opacity from less marked internal inflammation of the eye is not so unequivocal. I am, however, satisfied that in those slow insidious forms of inflammation which destroy the retina and cause what is called amaurosis, the lens is frequently rendered opaque; and to this cause are many of the soft blue lenticular cataracts of earlier life to be attributed. Not only am I satisfied that this is the case, but I am convinced that in many cases this form of inflammation causes opacity of the lens with-

out destruction of the retina or amaurosis, and hence the doubt which must exist as to the success of operations in such cases. That central opacity of the capsule follows penetrating ulcers of the cornea, or slough in the purulent ophthalmia of infants, and the ulceration from pustules in small-pox, has been already stated, and it appears only reasonable to attribute such opacity to the inflammatory action which accompanies these ulcerations.

That cataract is produced by injury, no one will, I believe, deny. Puncture of the capsule by a sharp instrument, as often occurs from the accidental thrust of an awl, a fork, or a needle, or from a thorn by a slap of a bush in crossing a hedge, is immediately followed by opacity or cataract. I think I have seen the lens quite milky in ten minutes after the accident. In fact, the moment the capsule is torn open, the soft fibrous lens begins to imbibe the aqueous humour, and speedily expands, and becomes opened in its texture, at the same time losing its delicate transparency and acquiring a milky appearance. The capsule of the lens is sometimes, although very rarely, burst by a blow, without any penetrating wound of the eye, causing opacity of the lens, and its ultimate absorption. But not only is the lens rendered opaque in this way, but it is a fact, that a blow on the eye sometimes causes opacity without rupturing the capsule at all. How this happens is not very certain, but it may be caused by the detachment of the lens from its connexion within the capsule by the shock of the blow; or it may be, that the cataract in such case is a consequence of inflammation from the injury.

It has been said that cataract sometimes takes place suddenly, and this has been attributed to rupture of the capsule in convulsions, but I very much doubt the truth of these statements. I never yet met a patient who had

cataracts in both eyes and could prove that they took place suddenly, although I have met many who asserted that single cataracts had appeared on one particular day. The real truth being, that blindness of one eye from cataract, or any other cause, may exist for a long time without a person being aware of it, until informed by attempting for the first time to view an object with that eye, the other being closed, or until it is obseived by another person. Every one conversant with diseases of the eye must have observed how often very imperfect vision of one eye exists without the patient knowing it: so little are some persons in the habit of observing or paying attention to occurrences which do not materially affect them.

Of remote causes of cataract we have little evidence. Hereditary predisposition is generally considered to exist, and perhaps there may be some truth in the conclusion, but I cannot say that I have been able to establish the fact in a sufficient number of cases to justify a positive assertion of its operation. Exposure to strong light and heat has been enumerated among the remote causes; and cooks, glassblowers, workers in foundries, and smiths, have been held more liable to the disease than others. Experience, however, does not verify such statements, which have probably been repeated by successive writers upon some remote authority not much to be relied on. Mr. Mackenzie says he met with the disease at one time frequently among stocking-weavers, and I, if I instituted an inquiry into the matter, should probably say that the disease occurred most frequently among labouring people. Chance may throw more cases of particular trades into one man's way than another. Constitutional disease, or derangement of important vital functions, might be supposed to be calculated to induce this disease, but it does not appear to do so. Neither scrofula, cancer, nor venereal, except so far

as they may cause it by leading to inflammation, seem to produce it. Mr. Mackenzie says he met three instances in cases of diabetes mellitus, and I think I have myself seen two or three also.

OF THE SYMPTOMS AND PROGRESS OF CATARACT.

When sight becomes impaired, without opacity of the cornea or contraction of the pupil, the defect is naturally attributed either to opacity of the lens or loss of sensibility of the retina; in other words, to cataract or amaurosis. It is, therefore, necessary in such cases to ascertain how far the disease is owing to the one or the other. The patient in both cases complains of loss or imperfection of vision, but in cataract he complains of a cloud, fog, or smoke interposing between him and objects; while in amaurosis he rather thinks that he cannot see from want of light, or some inexplicable inability to distinguish objects. In cataract, I think that the patient when nearly blind can judge better of the form, colour, and distance of objects, than he can in amaurosis impairing vision to the same extent. In both, ocular spectra, muscæ volitantes, floating motes, smuts, and films, with or without luminous clouds and scintillations, may be present, or they may not exist in either, being I believe consequences of inflammatory action. In incipient cataract there is generally a change in the optical construction of the eye, causing indistinctness of vision and loss of power of adaptation and adjustment. So much so, that in many cases temporary relief is derived from the use of lenses of short focus, and in near-sighted persons concave glasses are abandoned, which is not so much the case in amaurosis. In incipient cataract, also, objects often appear distorted and multiplied; the

print in a book appears thrown out of line, and the sashes of the window appear doubled. The candle, also, often appears as if with rays extending from it, and the circular disc of the full moon appears broken at the edge, or the candle and lamps in the street appear enlarged, and not sharply defined; while in amaurosis there is more of haziness, with spreading of the luminous point into a diffused patch. In cataract, patients generally see a little better with the back to the light, or even in a weaker than in a stronger light, because the pupil is then enlarged, and a larger passage is formed for the transmission of the rays; while in amaurosis vision is improved in strong light, unless there be an irritable or excitable state of the retina from inflammatory action. The admission or assertion of a patient as to the existence of all or any of these symptoms, cannot, however, be considered conclusive of evidence of incipient or advanced cataract, there must be some visible opacity of the lens to justify us in pronouncing positively that the disease is present. Yet even this is not so easily ascertained as might at first sight appear. On looking into the eye, an observer may perceive a degree of cloudiness or milkiness of the lens which may lead him to believe that cataract has commenced, but he must not decide too hastily from this, because a perfectly transparent lens seen through a naturally large pupil, or through one dilated by belladonna, with the light reflected from its surface, appears milky; and in aged persons the amber-coloured lens, viewed under similar circumstances, appears very opaque, although really not passing into the state of cataract at all. If the defect of vision be but slight, and the opacity but inconsiderable, it is not easy to determine positively whether or not the defect is to be attributed to the opacity or to the state of the retina, but when vision is nearly lost from cataract, the opacity is so obvious that

there need be no doubt on the subject. In fact, if a patient declares that he can only distinguish light from darkness, or that he can merely perceive that the hand is passed back and forward before his eyes, there must be visible cataracts to account for such blindness; and if there are none, or if there is only a slight milkiness of the lens, the blindness must be referred to the retina. In other words, if a man be blinded by cataracts, we have only to look into his eyes and see them. It is in incipient cataract that any difficulty exists of ascertaining the nature and amount of the opacity, or of discovering that it is owing to this cause and not to incipient amaurosis that the defective vision is due; and it is therefore in such cases that dilatation of the pupil by belladonna must be resorted to in order to obtain a full view of the lens. With this most valuable aid, and with the assistance of a good large convex lens of about two and a half or three inches focus, I can with safety say that I never fail to satisfy myself on the subject; slight opacities, whether general or partial, becoming thus distinctly visible, especially when a strong light is reflected from the surface of the lens to the eye of the observer, or when not so reflected, he looks deeply into its texture. I must, however, warn those who have not acquired the art of adjusting a lens so as to bring it to the proper place between the eye of the patient and the observer, that they must not expect satisfactory results from this method of examination. I have also to warn beginners against resorting to the dilatation of the pupil by belladonna without some consideration, especially in aged persons; because the effect of such dilatation in a sound eye is to cause great defect of vision while it lasts, and often in incipient cataract the same result follows, and is immediately felt by the patient, who ever after attributes his loss of vision to this cause.

In endeavouring to arrive at a correct diagnosis of cataract, the way in which the patient carries his head and directs his eyes may be worth noticing. In cataract, some vision always remaining, the patient continues to direct his eyes in search of objects; while in amaurosis, especially if complete, there is a vacant stare which proclaims that he cannot see, and that he feels that there is no use in attempting to do so. The state of the pupil and power of contraction in the iris is also worth noticing, although frequently affording little additional information. If the pupil be permanently dilated, we may generally conclude that the retina is insensible to light whether there be cataract or not, but mere sluggishness in the action of the iris, or even immobility of the pupil, should not be considered conclusive evidence of amaurosis; because in aged persons especially, the iris very often loses the power of active dilatation and contraction without any corresponding defect of vision. It seems to be very generally assumed that if the retina becomes either partially or entirely insensible to light, the pupil must of necessity be dilated, because in the sound eye it is dilated when light is diminished; but experience teaches us that in the majority of cases of amaurosis there is no dilatation of the pupil. In the same way it is, or it may be, inferred that when light is excluded by cataract the pupil is dilated, but we know that it is not so. Consequently the state of the pupil does not assist us much in our diagnosis of cataract. If, however, in younger persons the pupil neither dilates nor contracts under changes of light, with or without cataract, insensibility of the retina may be inferred.

Much unnecessary doubt has been created with respect to the diagnosis of cataract by giving to certain combinations of cataract and amaurosis another name; and describing under the title of glaucoma appearances which

depend upon the presence of an amber-coloured lens with extensive alteration of structure in the other parts of the eye. Glaucoma appears to me to be merely that state which follows general inflammation of the eyeball of chronic character in persons more or less advanced in life. The bloodvessels are permanently enlarged, the pure white of the sclerotic is changed to a yellowish or dusky tinge, and the cornea and lens, and perhaps sometimes the vitreous humour, lose their perfect transparency and freedom from colour; the pupil being at the same time dilated, and the eye soft from disorganization of the hyaloid membrane. This is not progressive disease, but the consequence of disease; in fact, the effect of inflammation, the existence of which it is very important to ascertain where cataract is in question, but which we need not seek to distinguish from cataract, for frequently that disease is accompanied by this very state of the eye. Opacity of the lens may properly be called cataract, and loss of sensibility of the retina may also be called amaurosis; but I cannot see the necessity of calling amaurosis with a yellow lens glaucoma.

Much has been said and written about another method of detecting incipient cataract. It is called the catoptrical test. A lighted taper is to be held a few inches from the eye, and moved from side to side and up and down. If the lens be perfectly transparent, one upright image of the taper is seen reflected from the cornea; a second, also upright, supposed to be from the anterior face of the lens; and a third inverted, supposed to be from the back of the lens. If the lens be opaque, the third or inverted image is either indistinct or absent. To this method I have not in my own practice attached much value, because I find that if the sensibility of the retina is considerably impaired or destroyed, or in other words, that the eye is amaurotic, and that at the same time the lens is perfectly transparent,

I have only to look into the eye and see that it is so; and if, on the other hand, vision is much impaired, and the lens so opaque as to obliterate the third inverted image, I have also only to look and see it. Besides, I believe that in many old persons the lens is so coloured and milky, although not affected with cataract, that no inverted image is seen in their eyes.

Many may, however, find the method useful, for it is relied upon by Dr. Mackenzie and others as a valuable means of diagnosis. My myopic eyes, too, which I find so available in minute operations, may not admit of that adjustment which this experiment requires, and therefore perhaps it is that I do not find it answer. Without advancing any claim to superior address in the investigation of the state of the lens when supposed to be partially opaque, I may observe that I have often felt surprise at the apparent difficulty experienced by observers in determining the question. With a glass of short focus and a strong light reflected from the surface of the capsule, I seldom find it necessary even to dilate the pupil in order to satisfy myself as to the condition of the lens. Persons with presbyopic eyes may not, however, find it so easy to accomplish the same object, because they cannot so easily adjust the eye to bring an exceedingly minute portion of an image to its place on the retina. Whatever inconvenience may be experienced in early life by short-sighted persons, it is counterbalanced by this state of vision at a more advanced period, enabling them to pursue occupations which they should otherwise be compelled to abandon.